Nov. 29, 1955 A. R. PIERCE 2,725,224

DRY KILN APPARATUS

Filed May 11, 1953 3 Sheets-Sheet 1

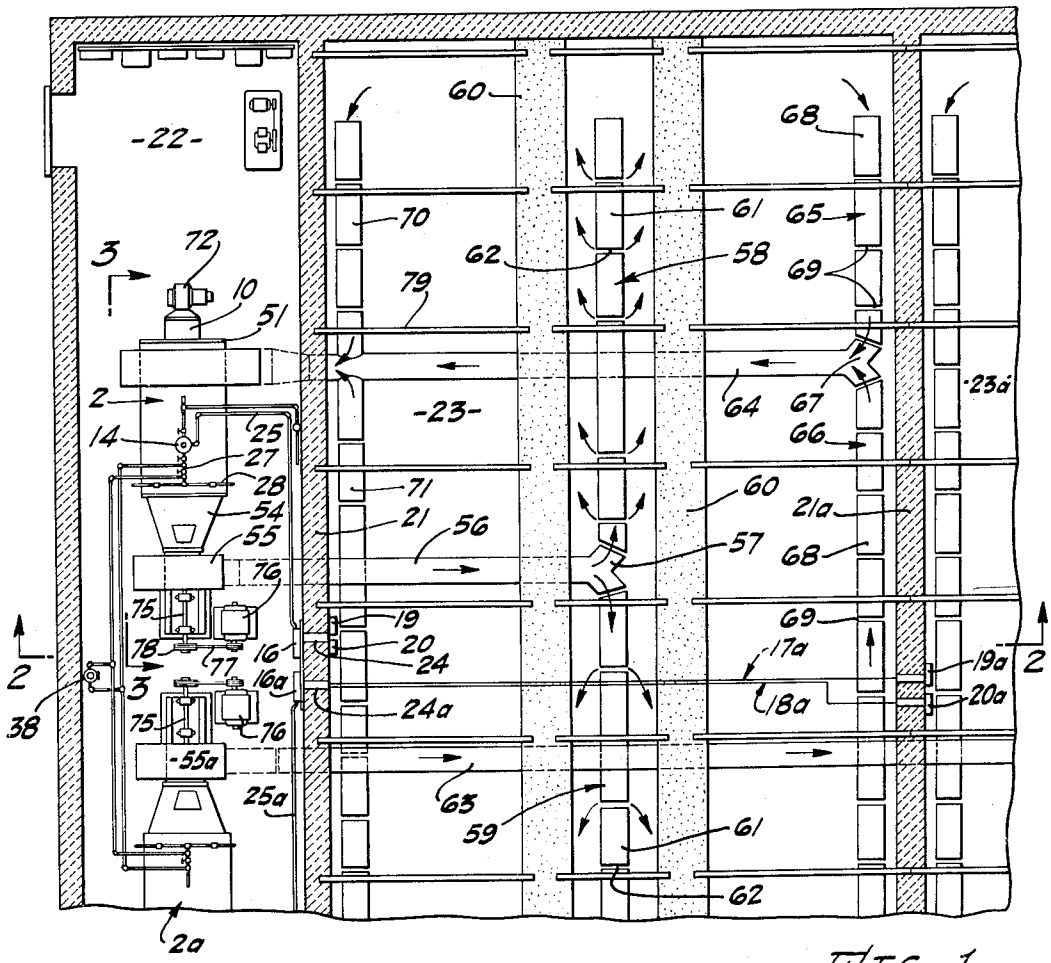


FIG. 1.

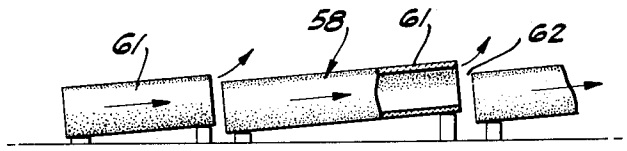


FIG. 7.

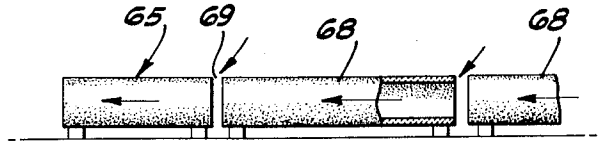


FIG. 8.

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DRY KILN APPARATUS

Filed May 11, 1953 3 Sheets-Sheet 2

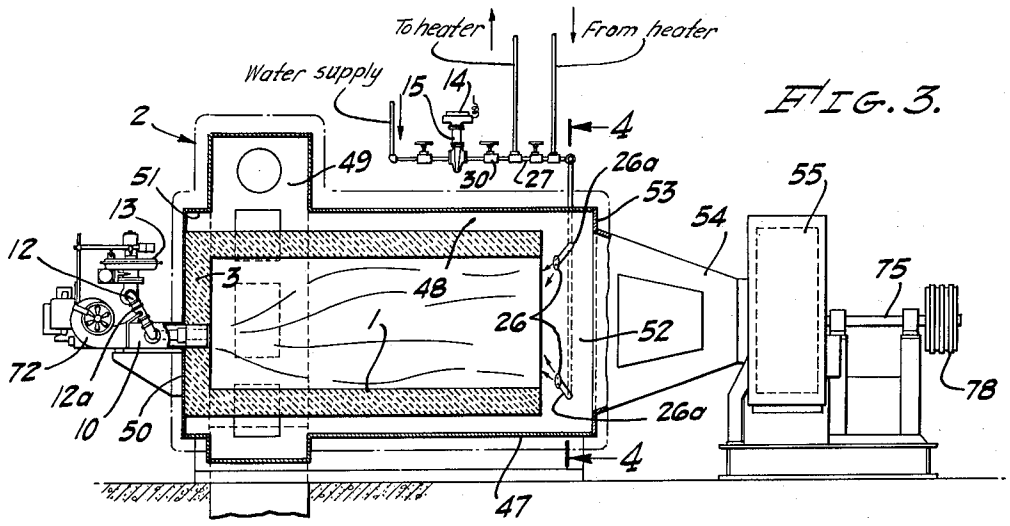


FIG. 3.

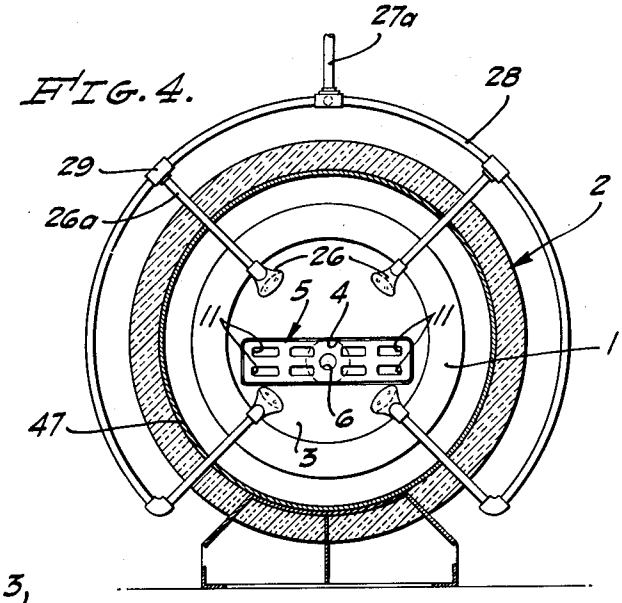


FIG. 4.

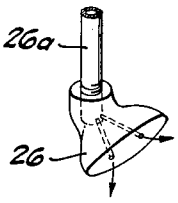


FIG. 9.

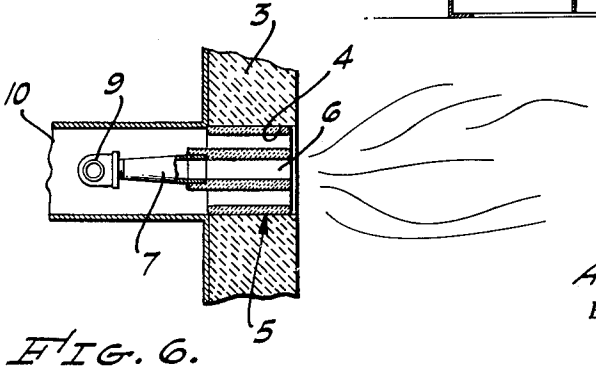


FIG. 6.

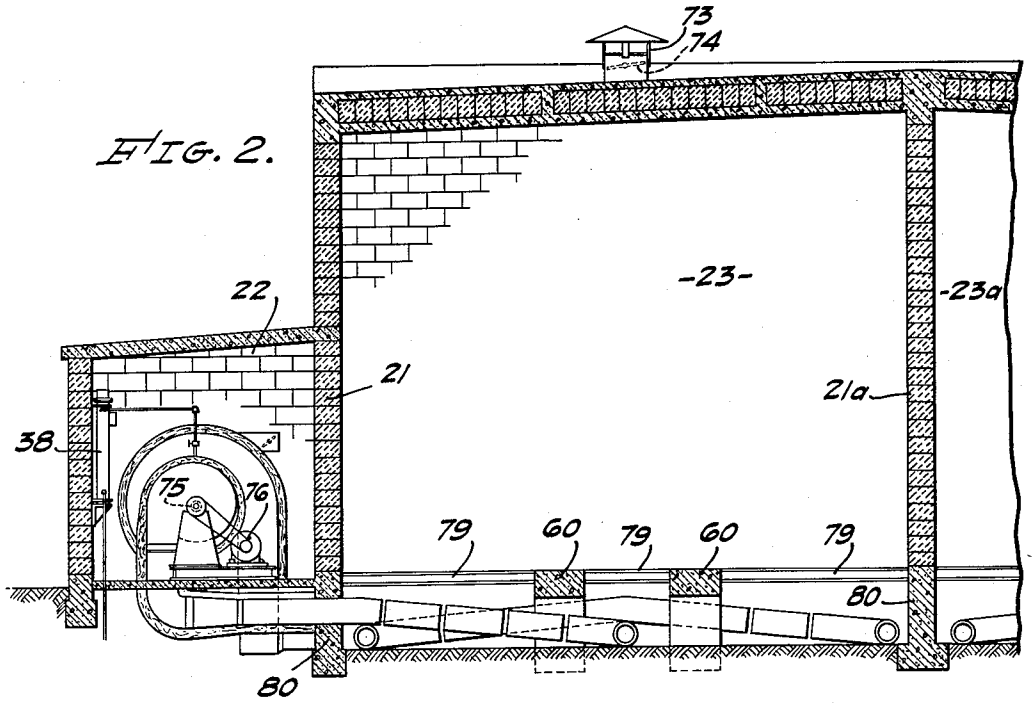
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Filed May 11, 1953 3 Sheets-Sheet 3

FIG. 2.



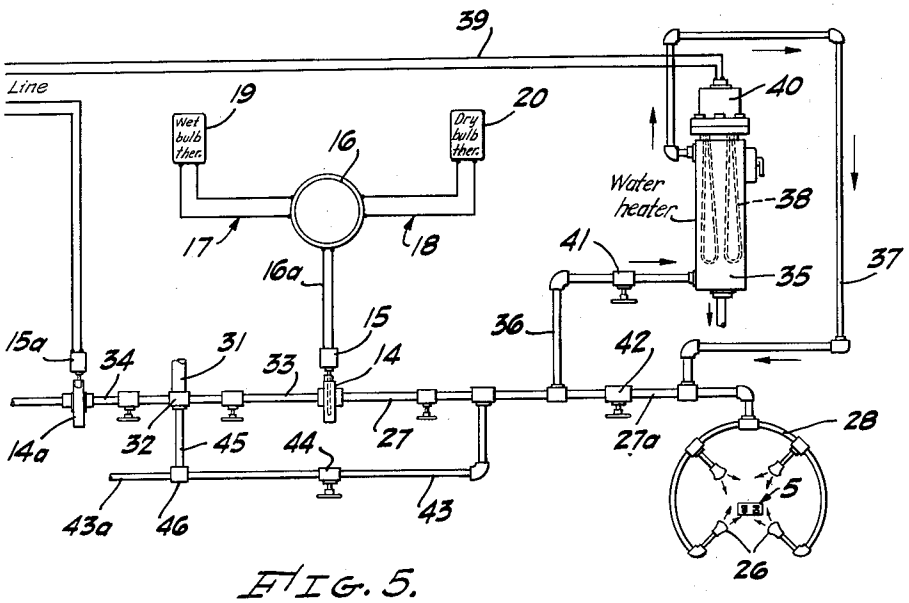


FIG. 5.

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2,725,224

DRY KILN APPARATUS

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Application May 11, 1953, Serial No. 354,116

2 Claims. (Cl. 263—40)

This invention relates to dry kilns, and while it may be used in the equipment and operation of drying kilns used for any specific purpose, in the present specification it is described and illustrated as applied to kiln for drying and conditioning lumber.

In accordance with the present practice in dry kilns, the equipment usually includes heating coils for heating air that is then delivered into the kiln chambers. Steam boilers are also provided that deliver steam into the kiln chambers, and the hot air and steam are then mixed mechanically within the chambers of the kiln by power-driven fans within the chambers.

The apparatus briefly described above is relatively expensive, and the heating coils are subject to corrosion, and require considerable servicing after extensive use. The impeller fans, located as they are, in the hot damp air within the kiln are apt to require attention on account of bearing trouble. And, of course, any servicing to make repairs necessitates shutting down the kiln thereby causing a direct loss in effective kiln operating time, and also a loss in heat consumption due to the cooling off of the hot kiln.

One of the objects of the present invention is to provide an efficient method for drying and conditioning lumber, that in addition to its efficiency, can be carried on with relatively simple and inexpensive apparatus and the operation of which can be carried on continuously and with a minimum of heat losses due to shut downs of the kiln.

Another object of the invention is to provide a method and means for effecting the direct supply of a hot, and moist, heating medium, to the kiln; and in the use of which the heating and introduction of the moisture into the drying medium can be very nicely regulated.

Further objects of the invention will become evident from a careful reading of the present specification, and a careful study of the accompanying drawings.

The invention consists in the novel parts and combinations of parts to be described hereinafter, all of which contribute to produce an efficient lumber drying and conditioning.

In the drawing:

Figure 1 is a horizontal section though the walls of a kiln showing the general arrangement of the equipment and the location of the furnaces, blowers, and the circulating system for the hot moist medium through the kiln.

Figure 2 is a vertical section taken about in the plane of the line 2—2 on Figure 1.

Figure 3 is a side elevation, and section through the furnace taken along the line 3—3 of Figure 1, upon a larger scale than Figure 1.

Figure 4 is a vertical cross-section taken on the line 4—4 of Figure 3.

Figure 5 is a diagrammatic view of the water system including the piping and spray nozzles and the controls therefor.

Figure 6 is a vertical section through the burner that provides the flame in the fire box of the furnace.

Figure 7 is a fragmentary view, partially in elevation and partially in section, illustrating the preferable arrangement of ducts in the inlet branches of piping for the heat medium.

Figure 8 is a view similar to Figure 7, but illustrating the preferred arrangement of the ducts in the outlet main for the heating medium.

Figure 9 is a fragmentary perspective showing one of the water spray nozzles and a portion of the radial pipe leading inwardly to the same.

Referring now to Figure 3, the fire box 1 of the furnace 2 that is illustrated, is of cylindrical form, and composed of suitable refractory material. As shown in the drawing, the right end of the fire box is open, and the left end has a transverse head 3 also of refractory material and provided with a wide socket 4 of slot form located concentrically on the longitudinal axis of the fire box 1. The socket carries a refractory burner 5 with a centrally disposed fuel duct 6, supplied with fuel oil or gas. For this purpose a good quality of butane may be used, or commercial gas from the city mains. The fuel is led into the rear of the duct through an adapter thimble 7 connected to an elbow on the axis of a tuyère 10 that supplies air to the air ports 11 of the burner.

The fuel is delivered to the inlet pipe 9 by a pipe connection 12 that leads down from a pressure-regulator assembly 13. This pipe connection 12 contains a hand valve 12*a*, an automatically controlled water valve 14 is provided that is controlled by a solenoid 15, see Figure 5, and this solenoid in turn is controlled by a control instrument 16, the wires within which is controlled by the temperature in a wet-bulb thermometer 19 and the other is controlled by the temperature in a dry-bulb thermometer 20.

Referring now to Figure 1, it should be said that each chamber in the kiln carries a pair of these thermometers operating to give dual control of the valve 14. In Figure 1, these two thermometers 19 and 20 are indicated on the inner face of the wall 21 that separates the furnace room 22 from the chamber 23 of the kiln.

The wires for the circuits 17 and 18 pass through a duct 24 in the wall 21 and connect up to the control instrument 16 on the furnace room side of this wall 21. From this instrument 16 the wires form a circuit 16*a* passing in a pipe conduit 25 over to the control-valve at 14 in Figure 1.

Also, in Figure 1, the corner of a second chamber 23*a* is shown at the right of the partition wall 21*a* that divides the chamber 23 from the 23*a*. The chamber 23*a* is provided on the side of the wall 21*a* with a wet-bulb thermometer 19*a* and a dry-bulb thermometer 20*a* which are counterparts of these instruments 19 and 20 already referred to; and control circuit 17*a* and 18*a* for these instruments pass under or around the chamber 23 and through the wall 21 at the duct 24*a*, emerging on the furnace room side of the wall 21 where they connect up to a controlling instrument 16*a* similar to the instrument 16, and the wires from which pass through a piping conduit 25*a* similar to the conduit 25 already described. The circuit wires in the conduit 25*a* connect up to an instrument similar to the instrument 16 which is associated with another furnace 2*a* similar to the furnace 2, the latter of which is in a reversed position with respect to the furnace 2. The latter is completely illustrated in Figure 1.

It should be understood that furnace 1*a* and all equipment co-operating therewith is substantially identical with that illustrated fully in connection with the chamber 23, so the specification now will be confined to the equipment associated with chamber 23.

Referring now to Figures 1, 3, and 4, from the control valve 14, that delivers water to the spray nozzles 26 that I employ in each furnace. As illustrated in the drawing, I provide a delivery pipe 27*a* that receives a controlled water supply from the valve 14, which is connected to an arcuate main-pipe 28, see Figure 4, that is bent on a slightly larger radius than the inner surface of the fire box 1; and this arcuate pipe 28 is provided with T-connections 29, carrying radials 26*a* that carry the nozzles 26. The radials extend in a general radial plane towards the axis of the fire box, but inclined inwardly and toward the end of the fire box that carries the burner 5. With this arrangement, it will be evident that when the water finds exit through the spray nozzles 26 of the spray will be injected into the fire box in a direction against the direction of movement of the flame of burning fuel that is moving toward the outer end of the fire box. In practice, the pipe 27 contains hand valves 30. These are shown in a horizontal extension of the pipe.

Referring now to Figure 5, the water supply is delivered through a water service pipe 31 at ordinary service, pressure, and in the present instance this supply pipe is connected to a T-connection 32 that supplies the water through a pipe 33 which is separated from the pipe 27 by the controlled valve 14 already mentioned. On the other side of the T 32 it is connected to a similar pipe 34 that delivers the water to the furnace 2*a* through a controlled valve 14*a* that is similar to the valve 14 and actuated by its own solenoid 15*a*.

In the pipe-line between the pipe 27 and the arcuate "water ring" 28 an electric heater 35 is provided, and the water that passes up through this heater is delivered to it through a branch pipe 36, and from the heater the water passes to a pipe 37 the lower end of which connects to an extension 27*a* of the pipe 27 already referred to, and this pipe delivers the heated water to the water ring 28; the heater elements 38 shown in dotted lines are supplied with current from a circuit 39 by means of a control device (not illustrated) which delivers the water from the heater 35 to the desired temperature; and in the present case, this temperature is slightly above the boiling point of the water. This temperature is preferably 250 degrees Fahrenheit. If the electric current applied in the circuit 39 is an ordinary 110 volt circuit this circuit may be connected into a transformer 40, the secondary coil of which steps up the voltage for the heating elements 38.

In order to enable flow of water to the spray nozzles 26 to be maintained for their protection when the sprays are not working by reason of the fact that the humidity in the kiln chamber has reached a desired point, I provide the pipe 36 with a hand operated valve 41, and in the pipe 27*a* a hand valve 42 is provided. These valves can be "cracked" to permit just sufficient flow of water to the water rings 28 such as in the nozzles 26 to protect them from the furnace heat. Of course, the valve 42 would be closed most of the time, and always while the hot air and gases of combustion are being humidified by the sprays.

In addition to this, I provide a by-pass pipe connection 43 around the controlled water valve 14, and this by-pass pipe is provided with a hand valve pipe 44 which is normally closed. However, this valve would be open at the same time that the valve 42 is open to pass a water dribble to the ring 28, and when for any reason the water heater is cut out of operation. The pipe 43 receives its water from the pipe 45 through a T-connection 46 that also supplies water to a by-pass pipe 43*a* for by-passing the other automatic water valve 14*a*.

Referring again to the furnace 2 and the pipe system for circulating the heating medium through the kiln; as illustrated in Figure 3, the furnace has a jacket 47 which completely envelops the fire box. This jacket has a cylindrical body, the wall of which is separated from the outer face or surface of the fire box 1 by an annular space 48 and includes an upper extension 49 communicating with the annular space 48. These parts operate as an inlet hood or receiver for effecting recirculation of the heating medium when it returns from the kiln chamber 23. The details of that will be described, hereinafter.

The jacket 47 is itself provided with lagging of insulation indicated by the dotted line 47*a*. It also has a flat head or transverse wall 50 which lies flatly against the outer face of the fire box head 3 and surrounding the location of the head 3 there is an extension 51 of cylindrical wall of the same diameter as the cylindrical part of the jacket 47. At the delivery end of the fire box a chamber 52 is formed the end wall 53 of which carries a substantially conical trunk connection 54, the small end of which is attached to an exhaust fan 55. Its impeller withdraws the humidified gases of combustion from the chamber 52, and concentrates them as they pass into a delivery main 56 which is composed of terra cotta pipe-sections. It carries the heating medium to a Y-connection 57 delivering the heating medium into two branch conduits 58 and 59 of terra cotta that extend longitudinally of the chamber 23. These are located in line with each other between two concrete tracks or ramps 60, on which wheeled trucks can be moved into the kiln chamber 23 from the end of the same that is broken way, at which point a doorway (not illustrated) is provided for the trucks to pass in.

The main 56 is composed of a continuous closed pipe with its sections connected together, end to end.

For the purpose of distributing the heating medium along the longitudinal axis of the chamber the branch pipes 58 and 59 are composed of short lengths 61 of pipe which are in axial line with each other but spaced apart to form gaps 62 through which the medium can escape into the interior of the chamber 23. In order to facilitate this escape, I prefer to place the sections 61 in a tilted up position toward the delivery end of the branch lines 58 and 59. This is illustrated in Figure 7. The advantage of this is that the delivery end of this pipe section 61 is slightly elevated above the inlet end of the pipe section that is receiving most of the current of heating medium that is flowing through.

The furnace 2*a* for the chamber 23*a* also has an exhaust fan 55*a* which co-operates with it in the same manner as the exhaust fan 55 co-operates with its furnace. The exhaust fan 55*a* delivers the heating medium through a continuous closed delivery main 63 of terra cotta pipe which passes completely through or under the chamber 23 and past the partition wall 21*a* into the far chamber 23*a*; and in that chamber the main 63 connects to branch pipes (not illustrated) but which are similar to the branch pipes 58 and 59 and are associated with each other in the same way as illustrated in chamber 23.

The exhaust system of piping for returning the heating medium to both the furnace 2 and 2*a* are substantially alike, and the system for chamber 23 will now be described. This system includes a return main 64 which is composed of continuous closed pipe, that is fed with returning hot medium through two return branches 65 and 66 that connect to a Y 67 at the inlet end of the main 64. These branches 65 are composed of short pipe sections 68 that are supported near together but set with their adjacent ends spaced apart to form gaps 69 through which the circumambient hot medium may enter from the interior of the chamber 23.

The pipes or inlet branches 65 and 66 are located near the partition walls 21*a*. However, another pair of return branches 70 and 71 are employed located adjacent to the wall 21 and which deliver their return current as a lateral connection into the return main 64 near the chamber 49 and substantially in line with it.

This return branch 70 is composed of short sections of spaced pipe arranged to form inlet gaps as indicated in Figure 8.

The return movement of the spent heating medium is augmented by the action of the current of air that flows into the fire box **1** through the tuyere **5**, through which a continuous current of air is entrained by the action of a blower **72** which delivers the blast for the burner into the tuyere **10**. This blast accelerates the flow of the gases of combustion and air forwardly and through the chamber **52**, and co-operates with the exhaust fan **55** to maintain a partial vacuum in the chamber **52**; and by reason of this the return medium that arrives in the chamber **49** is entrained and drawn into the conical duct **54**.

Both the chambers **23** and **23***a* have air vents such as the vent **73** shown in Figure 2. The opening through which is closed and regulated by a butterfly valve **74**. This valve, of course, is equipped with control means (not illustrated) for operating it from a position in the fire room.

For driving the shafts **75** of the blowers **55** and **55***a* two electric motors are provided with driving belts **77** running over belt pulleys **78** on their shafts.

As indicated in Figures 1 and 2, the kiln chambers are provided with horizontal rails **79** disposed transversely to the ramps **60** and their upper faces are flush with the upper faces of the ramps. These ends of these rails are supported in the cement foundation walls **80**, and in the cement ramps **60**. These rails may be I-beams or channels, and operate to support stacks of lumber built up on them in the usual way with ample spaces through the stacks for permitting free circulation for the heating medium through the stacks. However, this is not illustrated, as it is common practice in drying kilns.

In accordance with my invention, in practicing the method, after stacking the lumber in the kiln chambers, I start up the furnace and the water heater **38** which supplies water to the spray nozzles **26**; and at the same time all the blowers are started up so that the gases of combustion and admitted air supplied to the furnace fire-box by the blower **10** are moved into the kiln chamber.

The control for the electric water heater (not illustrated) is set by hand to cause delivery of water at approximately 250 degrees Fahrenheit to the nozzles. As this water is under approximately 60 lbs. p. s. i. commercial line pressure, as soon as the spray passes from the nozzles **26** into the fire-box, which is not under pressure, it immediately vaporizes on account of its latent heat at 60 lbs. pressure. The water is vaporized into dry steam immediately at 250 degrees Fahrenheit. This action, of course, is accelerated by the flame, and the high temperature in the fire-box, the result is that in an extremely short period of time the heating medium will be raised to a very high degree of saturation with the moisture. The circulation through the lumber, of course, quickly heats the lumber but without drying its exterior. In this way the sap in the lumber becomes heated and becomes more or less dissolved in the moisture that is passing into the lumber in the heating medium. As this operation progresses, the wet and dry bulb thermometers **19** and **20** co-operating with their recording control instruments **16** and **16***a* control the water valve **14**. They are set by hand to the limit of saturation desired, and shut off at that point. But may be adjusted to supply additional water when necessary to increase the humidity and less water when the humidity arrives at the desired point with the kiln compartment. This heating is continued for a sufficient period of time in accordance with ordinary proved dry kiln practice, after which the furnace and blowers are shut down.

The regular procedure used on kiln drying lumber is followed through the drying cycle. That is, as the lumber becomes dryer, more heat and less humidity is forced into the kiln; that is done by normally setting the heat and humidity controller from time to time to the driest heat and humidity that you desire in the kiln based on the dryness of the lumber at that time. The dryness of the lumber is determined by the approved methods used by all kilns, so is not necessary to explain.

When the dryness tests show that the lumber has arrived at the desired moisture content, I start a period of conditioning it. By this I mean that I lower the heat in the kiln and raise the humidity from the percentage that I had in the kiln automatically at the end of the firing, which is generally 30 percent up to 85 or 90 percent. The time period of this conditioning depends entirely upon the species of wood. It will range from 24 to 72 hours. My reason for doing this is that all species of lumber during the drying cycle will develop a small amount of stress due to surface hardening. By this conditioning this stress is all relieved and all of the lumber becomes equalized in moisture content.

The above conditioning operation is accomplished very readily with the equipment that I have developed. All that is necessary to do is to turn the burner flame to a very low point and open up the water spray controls so that a maximum of spray is entering the heating chamber which vaporizes and is forced into the kiln compartment. When I consider that the conditioning treatment has been sufficient I shut off all heat, power and humidifier units, open the kiln door and remove the lumber.

Many other embodiments of the invention may be resorted to without departing from the spirit of the invention.

I claim as my invention, and desire to secure by Letters Patent:

1. In apparatus for drying lumber in a kiln, the combination of a fire box, means for maintaining a flame and an air jet projected into the fire box, means for maintaining a confined supply of water, and for raising the temperature of the same to a controlled temperature of approximately 250 degrees Fahrenheit, means for spraying the same at that temperature into the fire box, means for circulating the air and gases of combustion thereafter through the kiln, said circulating means including short sections of ducts laid with their ends adjacent to each other and spaced apart so as to form outlets permitting passage of the hot gases and air into the kiln at points dispersed throughout the area of the kiln, and automatic means for regulating the quantity of water admitted to the spray in accordance with the degree of humidity existing in the kiln.

2. Apparatus for drying lumber in a kiln, according to claim 1, in which the ends of said pipe lengths located down stream with respect to the direction of flow of the current through them are inclined upwardly above the mouths of the pipe lengths taking the current, so that a circumferential gap area between the pipe lenghts delivering the flow is formed through which the hot gases escape into the kiln chamber while flowing in the same general direction as said current.

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